Outcomes of the workshop: refining aerial surveys of kangaroos

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INTRODUCTION

What follows is an attempt to bring together the discussions at the workshop which was conducted separately from the formal presentations.

ROLE OF AERIAL SURVEY IN KANGAROO MANAGEMENT

Aerial survey should be as precise and as accurate as possible. However, precision was considered more important than accuracy if one has to be sacrificed, because being able to track density provides the best tool for management. Ideally, the monitoring method used must accommodate the trend to regional management and allow local population modelling. In most states, aerial surveys provide estimates of kangaroo density for extensive areas. Subdividing these areas to provide regional estimates would result in less precise estimates unless sample sizes were increased or the sampling strategy changed. The costs in doing so are likely to be prohibitive.

Surveys should have broad applicability in the sense of allowing information to be translated comparably between regions, regardless of the method by which the estimates of populations are made. This does not necessarily mean that there should be more commonality of methods between states. The point was made strongly that regardless of the method used in different states or different regions it was important to strive for similar output. For example, a density of nine red kangaroos per square kilometre in South Australia should be equivalent to a density of nine red kangaroos per square kilometre in Western Australia.

CORRECTION FACTORS

With a three year study beginning in New South Wales (Gilroy 1999) and further work proposed in Queensland (Lundie-Jenkins *et al.* 1999), both directed at answering certain questions about aerial survey methodology, it was too soon for the workshop to identify or recommend any permanent change in correction factors. However, interim changes (but conservative ones) could be recommended pending the outcome of the Queensland and particularly the New South Wales study. For the first time, a correction factor specific for grey kangaroos could be proposed. The idea was to work out a particular correction factor for grey kangaroos rather than multiplying the existing correction factors which had been originally determined just for red kangaroos. Current practice by each state except New South Wales is to simply multiply the "corrected" population estimate for grey kangaroos from fixed-wing surveys by 2 (South Australia and Queensland) or 2.5 (Western Australia). There was also discussion about whether it was appropriate to have correction factors for individual habitats or regional correction factors that would be applicable in all habitats (Pople 1999), with the latter receiving most support.

After a lot of discussion and review of available information (Table 1, Cairns 1999), it was agreed that, pending the outcome of further work to be completed in New South Wales in the near future, the following correction factors for grey kangaroos would be adopted in all habitats:

- 4.8 for Western Greys,
- 3.5 for Eastern Greys and,
- 3.5 for both species in New South Wales (because they cannot be readily distinguished from the air), representing a conservative correction factor.

It was also agreed that existing correction factors would continue to be used for red kangaroos (i.e., 2.29 for open vegetation cover, 2.36 for light cover, 2.43 for medium cover and 2.57 for dense cover). The current practice of multiplying counts of both red and grey kangaroos by $1/(1.474\text{-}0.0316T)$, where T is the temperature (°C) at survey height, for temperatures >15°C, should also be continued.

STRIP WIDTH

There is some interest in moving from sampling in a 200 m strip to a 100 m strip. Some data exist on the bias and repeatability of the narrower strip (Pople *et al.* 1998a; Pople 1999) which suggest that while bias is reduced, repeatability is poorer. Further work on this is planned in New South Wales. A concern that has frequently been raised is that to shift to a new method risks the

Table 1. Correction factors developed from previous studies at a range of locations in eastern Australia. For each location, the nearest major town is shown. Dashes indicate the species was either absent or at a density too low to be estimated. All correction factors have been developed for 200 m strip transect counts using the same aerial survey method. Open refers to grassland and open shrubland; wooded refers to vegetation ranging from low open woodland to woodland, and includes mulga tall shrubland.

Location (State)	Habitat	Red kangaroos	Eastern grey kangaroos	Common wallaroos	Western grey kangaroos
Longreach (Q)[1]	Open	1.7	10.2	3.8	—
Windorah (Q)[1]	Open	3.1	9.5	—	—
Blackall (Q)[1]	Open/wooded	2.6	5.0	4.1	—
Charleville (Q)[1]	Wooded	3.1	5.1	4.8	—
Bollon (Q)[1]	Wooded	1.8	4.0	—	—
Roma (Q)[1]	Wooded	0.7	3.4	—	—
Goondiwindi (Q)[1]	Wooded	—	7.6	—	—
Tibooburra (NSW)[2]	Open	1.8	—	—	—
Jerilderie (NSW)[3]	Open	2.3	—	—	—
Wilcannia (NSW)[3]	Wooded	2.4	—	—	—
Menindee (NSW)[4]	Open	1.8	—	—	4.8
Menindee (NSW)[4]	Wooded	2.8	—	—	16.7
Menindee (NSW)[5]	Open	2.5	—	11.1	5.9
Quilpie (Q)[6]	Open	1.8	—	3.9	—
Quilpie (Q)[6]	Wooded	4.2	—	23.3	—
Cunnamulla (Q)[7]	Wooded	3.8	3.5	—	—
Western Australian rangeland[8]	Open	2.3	—	—	—

[1]Pople *et al.* (1998b). [2]Bailey (1971). [3]Caughley *et al.* (1976). [4]Short and Bayliss (1985). [5]Short and Hone (1988). [6]Southwell *et al.* (1986). [7]Grice *et al.* (1990). [8]Southwell (1993).

continuity of the long-term population data for kangaroos that has been collected on aerial surveys. If all methods are essentially striving to estimate the same, true population density, then having a more precise and accurate method is surely desirable. Reworking previous estimates of population size with revised correction factors would be required for grey kangaroos. So long as this was done, either shifting to a new method or new set of correction factors, it should not compromise the accuracy of the long-term population trends. Obviously it is important to demonstrate that any new technique results in improved accuracy and particularly repeatability, before bringing it into widespread use. Clancy (1999) provided a strong case justifying the use of helicopters to survey kangaroos in Queensland.

SIDE-OF-AIRCRAFT

Another suggested change was to restrict counting to the southern side of the aircraft where visibility is generally better and the required correction factor would be smaller. The other advantage is that only a single observer would be required, providing some saving in labour costs, although these costs are likely to be small relative to the running costs of the aircraft. Furthermore, using only one observer effectively reduces the sampling intensity (in terms of area) by half, although the actual number counted would be reduced by less than half.

The effect of counting only on the southern side could be tested with any one of a number of aerial survey datasets, and there have already been two assessments. In the Queensland survey blocks, Pople *et al.* (1993) certainly found counts on the southern side were more accurate, but not consistently more precise than counts on the northern side of the aircraft. Similarly, the bias of counts on the southern side (determined from a comparison of fixed-wing and helicopter counts) was not less variable than the bias of counts on the northern side. Across a much larger area in Western Australia, Southwell (1993) found the southern side counts were both more accurate and more precise than counts on the northern side. Because there was only a slight loss in precision in using only the southern side counts over using counts from both sides, Southwell (1993) argued that counting only on the southern side was worth adopting. Historical data could be reanalysed using only the counts from the southern side, because side-of-aircraft is always recorded. "Southern side" correction factors would need to be determined and have been reported by Pople *et al.* (1993) and Southwell (1993).

INDIRECT MONITORING

A considerable amount of data relating to the harvest are collected every year by all states (e.g., Lundie-Jenkins *et al.* 1999). These databases are largely unexplored. They offer the opportunity to determine, by correlation with long runs of aerial survey data, whether or not chiller returns and other measures of harvesting activity provide an alternative means of monitoring the status of the population. Where information on population age structure is available, better interpretation of the data is possible. Any changes to the composition of the population resulting from food availability or harvesting may be reflected in the harvest data. Such data are supplementary to, rather than in place of, direct monitoring. They offer the potential of continuous monitoring of a population and monitoring in areas not surveyed directly. A number of assumptions would need to be satisfied for any harvest parameter to be an effective index and Southwell (1989) discusses possible violations of these assumptions. These include standardizing harvesting equipment, efficiency and conditions, and that the harvesting of each animal is independent and that animals do not learn to avoid shooters.

OBSERVER TRAINING

Beard (1999) provided the first extensive, quantitative look at variation among experienced and novice observers. Until now, most guidelines for training observers had been based on anecdotal reports. Consideration of observer differences had been restricted largely to single survey comparisons of the total counts of left and right side observers. After some discussion it was agreed that all teams conducting aerial surveys of kangaroos should adopt the concept of observers having a substantial period as a trainee, including tracking of their performance against an experienced (i.e., trained) observer. This has the opportunity to build confidence in an observer by the survey manager and will give more confidence in the value of the data.

There seemed to be agreement that about fifty hours in the aircraft was necessary until you could reasonably expect to use data from a particular observer and that this should comprise at least ten survey sessions. There is also probably a need for checking trained observers and this can be done by comparing left and right observers on a total survey, by comparing their totals. It was agreed that it was appropriate to continue the present practice of recording the names of the observers in reports and publications. Maintaining and being aware of a pool of trained observers was important in keeping the technique truly standardized.

A related issue is the importance of using pilots familiar with broad-scale, low level aerial survey and working with aviation companies sympathetic to the needs of such surveys. Essentially, pilots are part of the aerial survey team. It is inefficient to regularly have to train naive pilots at the start of a survey. Constant speed and height, accurate flying and efficient flight planning of fixed transect lines, conduct of surveys in appropriate weather conditions and optimizing observer comfort will be best achieved with pilots familiar with surveying wildlife populations. Finally, there is large advantage in working with aircraft charter companies aware of the need for flexible timing of surveys, largely because of weather restrictions, and prepared to provide recently serviced aircraft equipped with clear windows and a radar altimeter.

SAFETY ISSUES

Communications towers, electric and other wires represent a threat. It would be possible to have all of these identified in a Global Positioning Receiver (GPS) database which is regularly updated, and which would alert a pilot when there are hazards in the vicinity. This might be something for the future. Survey managers and observers should check with their pilot that he/she is taking appropriate steps in relation to Search and Rescue (SAR) requirements. This usually takes the form of a flight plan submitted to the aviation authorities or, these days, can be as simple as leaving a "Flightnote" which includes flight details and an estimated time of return with a person on the ground. The need to check that a pilot has a low flying endorsement was identified. There was also discussion about the limitations posed by restrictions on pilots in the number of hours they can fly on a day, the number of days without a break, and this has implications for survey planning.

There have been a lot of new developments in safety-related items of dress for people carrying out aerial surveys from helicopters, including helmets, survival gear, and suits in bright orange colours. All aerial work conducted by Conservation and Land Management (CALM) in Western Australia is covered by occupational Health and Safety regulations and this is the case in other states as well. Most of the regulations are requirements of the Air Navigation Regulations.

MINIMUM WEATHER CONDITIONS FOR SURVEY

Work by Graeme Caughley, David Grice and others showed the possible need to correct aerial survey data for air temperature, so this should be recorded routinely on all surveys and data corrected where appropriate. The question about the likelihood that kangaroos undergo metabolic acclimatization, however, was raised. Different temperature correction factors may need to be developed both regionally and seasonally. There was some discussion about the width of the seasonal window in which it was appropriate to do aerial surveys. The window is wider in the southern parts of the continent than in the north.

Concerning conditions for sighting kangaroos, the view was offered that cloud cover was less relevant than brightness (i.e., light level), and it was therefore appropriate for people to avoid conducting surveys in dull conditions and to record information about the weather on data sheets. It was agreed that there would always be an element of judgement in the decision to survey or not, but, likewise, agreement that surveys should not be undertaken in conditions of poor visibility. The issue of window haze was also discussed briefly. It is a common problem in old aircraft, but windows can be replaced.

CONCLUSION

No monitoring technique will ever be perfect, hence the continued refinement of monitoring techniques for kangaroos. McCallum (1999) offered a number of suggested directions for further improvement. Invariably, what methods are used represent a balance between cost, accuracy and precision. In the past, the costs of surveys have been borne mostly by the relevant state government department, but an increasing proportion of these costs are now being met by the kangaroo industry, usually in the form of a tag levy. The need to put a figure on the size of Australia's kangaroo population (i.e., an accurate estimate), at least that proportion that is exposed to commercial harvesting, and to track it through time (i.e., a precise estimate) is important for effective management. This is particularly so, as quotas, which are set as a proportion of the population, are the main form of regulation. As quotas are now being reached in many regions of Australia, there is increased pressure on managers from the kangaroo industry, the grazing industry and conservation groups to have accurate and precise estimates of population size. However, the need for regular, direct monitoring is also political. Being one of the largest harvests of terrestrial wildlife in the world and with a growing export trade, much attention is directed at the industry. It is important then, that it is well managed. This also makes kangaroo management a benchmark for the growing number of sustainable wildlife use operations elsewhere in the world.

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